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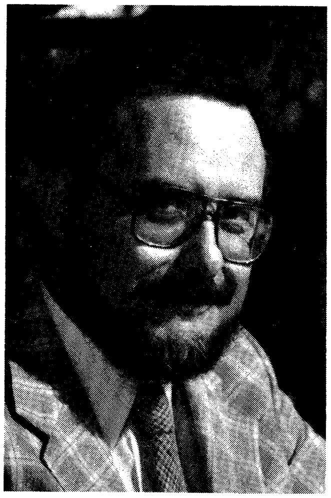

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By Dr. Donald W. Thayer

Dr. Donald W. Thayer is chief of the food safety laboratory, Eastern Regional Research Center, USDA, Philadelphia. His laboratory investigates problems involving the isolation, identification and quantification of contaminants and additives to foods.

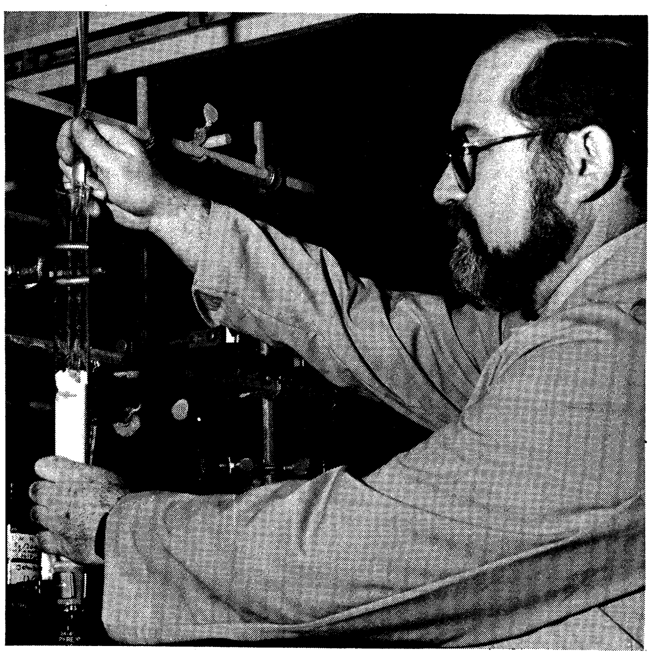
THE EASTERN Regional Research Center was established in 1938 and opened in 1940 under the name of Eastern Regional Research Laboratory. It has made numerous significant contributions to meat research, many of which resulted in increased use of both meat products and by-products.

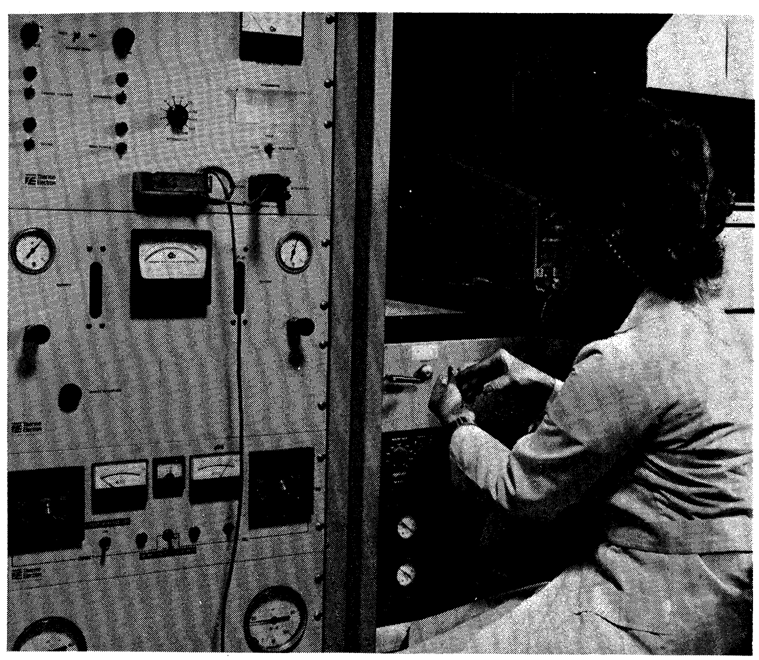
The Eastern Regional Research Center, with approximately 290 employees, was reorganized in 1981 into six laboratories: the animal biomaterials laboratory; the engineering science laboratory; the food safety laboratory; the food science laboratory; the physical chemistry and instrumentation laboratory, and the plant science laboratory. Each of the laboratories is divided into research units headed by a research leader. In general, ERRC research is concerned with post-harvest processing treatment and storage of agricultural commodities, some of which are discussed below.

Prior to 1962 meat packers had great difficulty in assigning numerical values to the various meat ingredients that would adequately predict their capacity to emulsify fat during the production of frankfurters and bologna. Scientists at the Center developed a simple test during 1959-1961 that accurately predicted emulsifying capacity (17). This was commercialized in 1962 and in 1972 was estimated as having had a net value to the economy of $14,000,000.

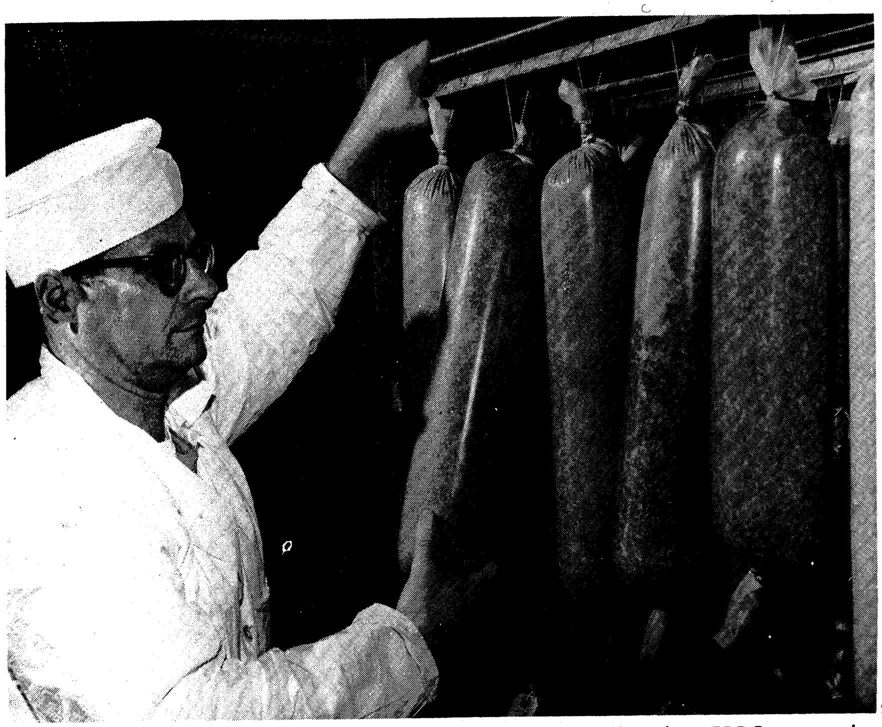
Some of the first determinations of the ultrastructure of bovine muscle tissue by scanning electron microscopy were done at ERRC. Studies of the changes in meat ultrastructure that result from thermal and tensile stress (3,6) led to new methodology for the analysis of meat tissue and new insights into the properties of raw and cooked beef.

The food science laboratory at ERRC studied food emulsions and obtained basic information on the in-





LEFT: Dr. Walter Fiddler is shown packing a column for subsequent analysis of fried bacon by the ERRC dry-column chromatographic procedure. RIGHT: Judy Foster is injecting a portion of the fried bacon extract with a gas chromatographic-Thermal Energy Analyzer system which measures volatile nitrosamines in very low concentrations—parts per billion.



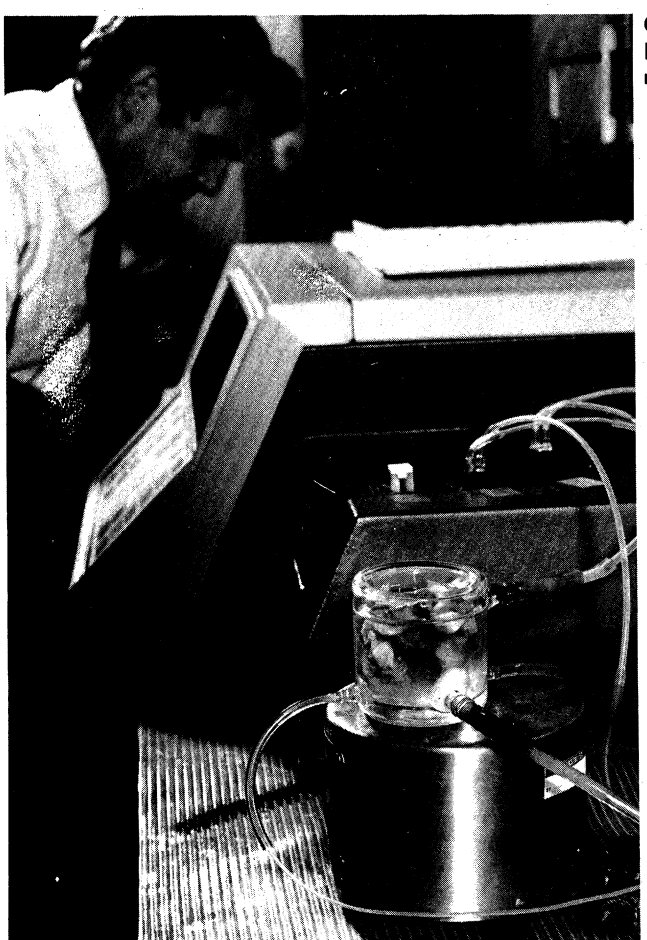
Dr. James Smith is examining experimental sausages produced in ERRC processing facilities for studying the microbiology of fermented meats.

environment. Analytical methods were developed to quantitate nitrosamines in foods and human physiological samples at the parts-per-billion level. Adipose tissue was found to contain the nitrosamine precursor in bacon (4). It was discovered that nitrosamines in bacon could be reduced to minimal levels by the use of a cure-solubilized formulation process containing vitamins E and C and by use of pre-processing techniques (5).

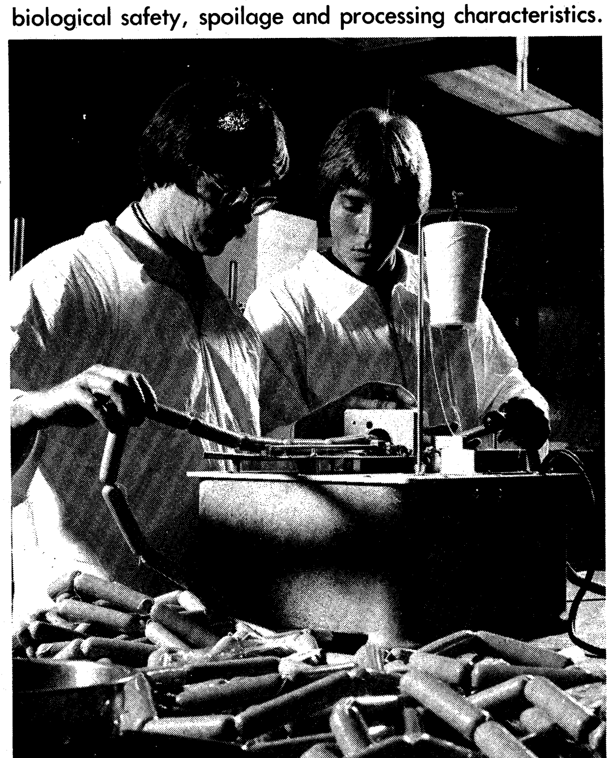
The discovery of the presence of a N-nitrosodimethylamine precursor in the air of certain tanneries caused the tannery suppliers to promptly replace the unhairing assist agent to eliminate this possible hazard to their workers (1). A rapid, inexpensive screening procedure was developed for the analysis of nitrosamines in bacon and was adapted for use on other foods (12). Development of extremely sensitive methods of analysis allowed the demonstration that neither volatile nor non-volatile nitrosamine contaminants of preplant, soil-incorporated herbicides were translocated through the soybean plant into the edible soybean. (7).

The discovery that rubber stoppers of blood collection tubes were contaminated with nitrosamines (8) led to the examination of other rubber products such as rubber nipples for infant bottles. As a result, the rubber itself is undergoing reformulation to eliminate the nitrosamines.

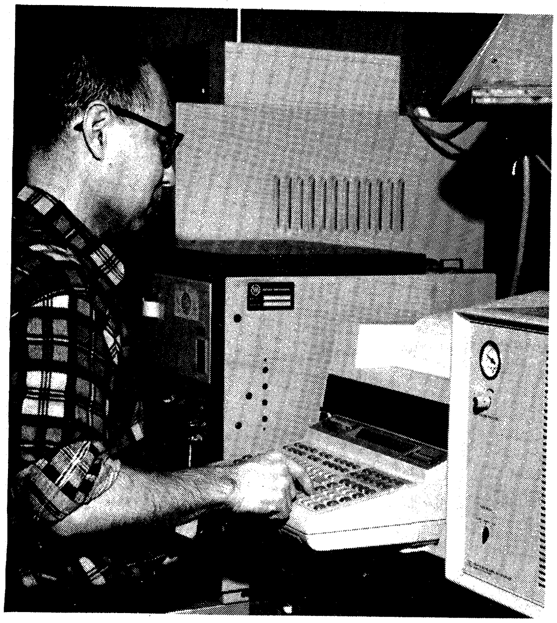
Recent and ongoing research on nitrosamines at ERRC has resulted in



Computerized spectrophotometry technique is used by Dr. R. C. Benedict to evaluate enzymatic digestion of beef connective tissue for restructured meats.



Dr. R. C. Whiting and C. A. Kunsch prepare frankfurters made with 40% reduced salt to examine its effect on microbiological safety, spoilage and processing characteristics.

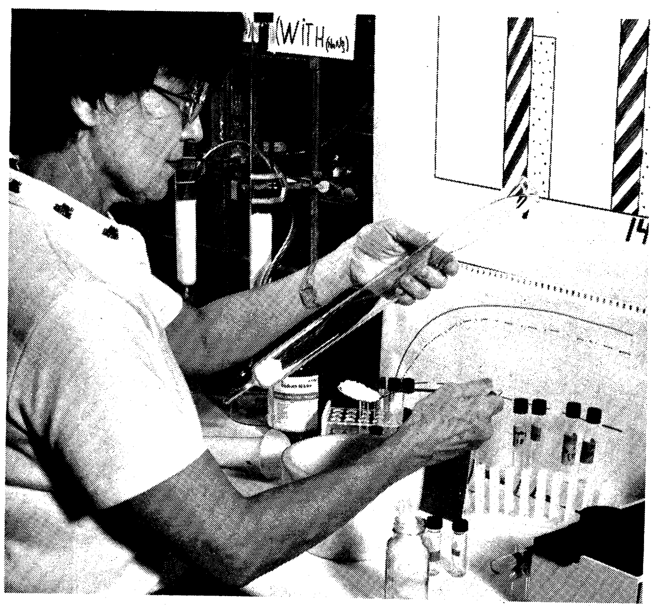


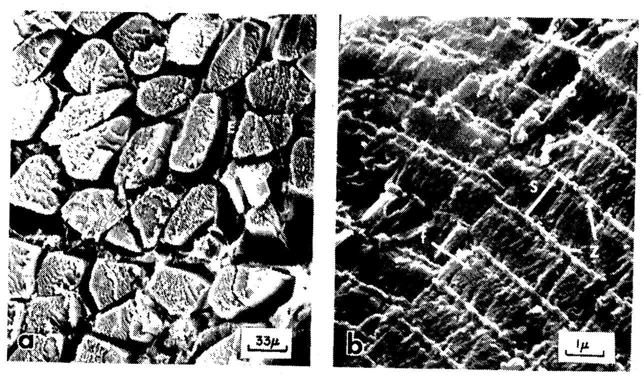
Dr. Walter Kimoto uses a benchtop gas chromatograph-mass spectrometer to confirm the identity of nitrosamines in a sample of fried bacon.

teractions that occur between lipids and proteins. Lasar-Raman scattering spectra revealed the effects of temperature on the molecular motion of lipids (16), and circular dichroism studies demonstrated that stronger phospholipid-protein complexes are associated with increased overall protein structure (2). NMR studies with synthetically labeled lipids revealed that cholesterol in model systems causes stiffening of phospholipid structures.

Scientists at the ERRC have also been very successful at developing uses for meat by-products such as tallow (10,9). Soap has almost completely disappeared from laundry detergents and been replaced by petrochemicals and polyphosphates. Because of rising costs and increasing scarcity of petrochemicals, tallow was examined as an alternate raw material. Though tallow soaps have been used for centuries, they don't perform well in hard or cold water.

USDA scientists found that lime soap dispersing agents (LSDA) could be added to soaps which drastically improved both their cold water solubility and their hard water detergency. The LSDA are anionic or amphoteric surfactants possessing one or more bulky polar groups. The soap and LSDA combinations wash well in hard water without curd formation. This product could provide an impor-





LEFT: Dr. Marta Zubillaga is shown evaluating the antioxidant activity of polar lipids from nitrite-treated pork. ABOVE: These scanning electron micrographs of bovine muscle show (at left) the cross fracture of muscle fiber, connective tissue-perimysium and endomysium and (at right) a higher magnification fracture plane parallel to fiber axis showing sarcomere delineated by the Z-line. BELOW: Dr. Warner Linfield is holding boxes of two Japanese household detergents containing soap and lime soap dispersant developed as a result of his research.

tant economic boost to the tallow industry.

During the early 1970s, following the discovery of nitrosamines in bacon and other cured meats, the U.S. Department of Agriculture undertook a major research program to determine how N-nitroso compounds are formed in meats. This effort included their analysis and the development of nitrite alternatives. Most of these studies took place in what is now the food safety laboratory and have led to reduction of nitrosamines in food, air, and water supplies. Some of those achievements, primarily under the direction of Dr. Walter Fiddler, are discussed below.

Studies on the chemical mechanisms of nitrosamine formation led to a greater understanding of why nitrosamines are present in foods and in the predictive equations will be developed and tested first in model and then in real food systems. It is hoped that data base and predictive equations can be provided that industry will be able to apply to their specific products.

A quantitative procedure for the determination of sulfamethazine (SM) in hog feeds was developed at ERRC which is delightfully simple in that it uses two plastic tubes arranged piggyback. The upper tube contains buffered anion exchange resin and acidic alumina, which removes interfering compounds. The lower tube contains an anion exchange resin buffered at pH 7.9, which quantitatively traps SM from the feed extract. In 10 minutes, feed samples can be screened for sulfamethazine using disposable equipment. This procedure is now undergoing a field test. It is hoped that it will allow the producer to identify and eliminate possible sources of withdrawal feed contaminated with sulfamethazine. A multiple residue laboratory procedure is now being developed for sulfa drugs in the presence of mono- and dinitrobenzamide coccidiostats and their metabolites in poultry tissues.

The animal biomaterials laboratory and the food science laboratory at ERRC are making a major effort to provide basic information on restructured meats, which will be valuable to the meat industry. Chemical, histological and histochemical, microscopic immunologic and enzymatic studies of connective tissue(s) should define its (their) contribution to restructured beef. The use of proteases and elastase to alter the properties of connective tissue are being examined.

The food science laboratory at ERRC is studying freeze-thaw injury in export meats. Preliminary results suggest that freezing of beef liver greatly increases the amount of lysosomal damge (measured by acid phosphatase activity) and only slightly increases the amount of plasma membrane damage as measured by lactic acid dehydrogenase activity.

The purpose of this report is just to highlight a few of the many research studies, which have been completed or currently are underway at the Eastern Regional Research Center, that are of interest to food processors.

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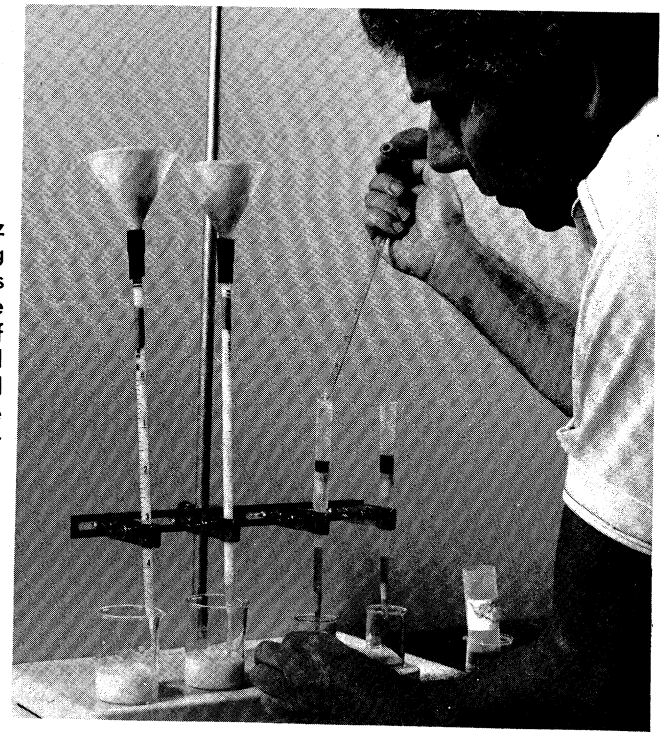
additional discoveries and developments. A dual column chromatographic-TEA method for N-nitroisothiazolidine (NTHZ) in bacon was developed (13) and applied to other cured meat products (14). Higher amounts of NTHZ were found in uncooked bacon compared to the corresponding cooked samples independent of cooking treatment or residual nitrite concentration. There appears to be a definite linkage between NTHZ and smokehouse processing. The kinetics of NTHZ formation, especially its relationship to smokehouse processing techniques, is currently being studied.

The ERRC dry column thermal energy analyzer (TEA) procedure for N-nitrosopyrrolidine (NPYR) in fried, dry-cured bacon was compared to the mineral oil-TEA, and the FDA multidetection procedures. The mineral oil-TEA procedure gave an average of 31% higher NPYR values compared to the other two methods (13). These results, and data obtained from other experiments, indicate a potentially serious problem with the current official mineral oil screening procedure, insofar as the potential for artifactual nitrosamine formation is concerned for products containing high levels of residual nitrite.

Prior to 1974, Lebanon bologna was largely restricted to southeastern Pennsylvania where it was produced by the Pennsylvania Dutch community. It was thought that the characteristic flavor of the bologna was due to the aging of the meat in wood barrels and the special smokehouse. Sam Palumbo and Jim Smith of ERRC demonstrated that continued use of old barrels was not necessary and, in fact, plastic bags could be substituted for the barrel (11,15). A 3% salt level that encouraged development of micrococci and did not inhibit the lactic acid bacteria was identified as being critical to the process. These and results of other studies of fermented sausage products by the scientists have resulted in better and greater marketability of sausage products.

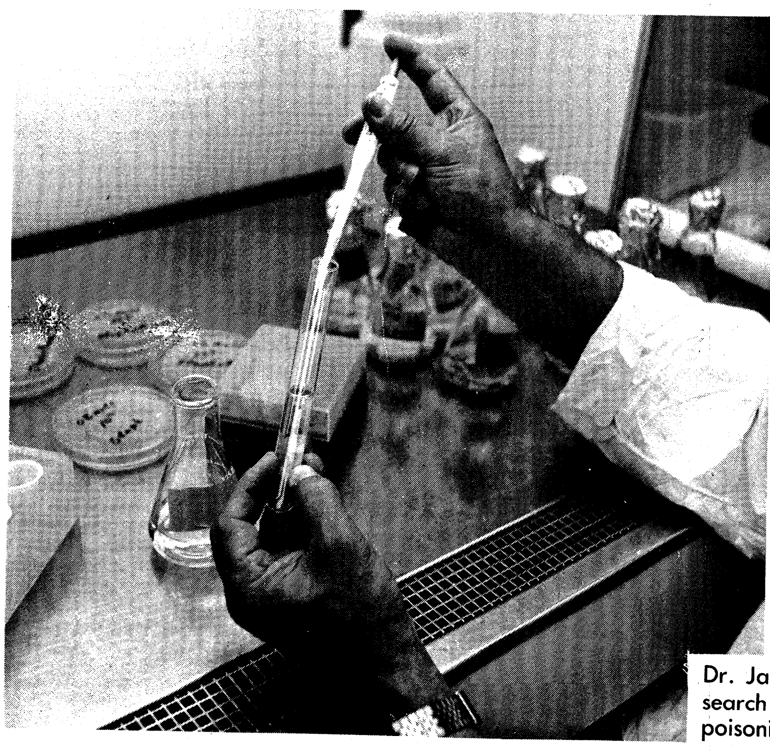


Dr. Daniel Schwartz is developing microcolumns for selective isolation of chloramphenicol in milk and sulfamethazine in swine liver extracts.

Processed meat products, including frankfurters, add a significant amount of sodium to our diets. Excessive sodium may be a factor in the development of high blood pressure in susceptible individuals. Research in the food science laboratory has demonstrated that the sodium content of the frankfurter can be reduced by 37% by replacement of 50% of the added sodium chloride with potassium chloride without affecting flavor. Much more basic research is underway in the food safety laboratory at this time on the interactions of salt with food pathogens and the complex interactions with the natural flora of meats.

The microbiological safety research unit is identifying and characterizing the genetic factors that control toxin formation in *Clostridia*. The bioregulation of toxic secondary metabolite synthesis by food poisoning microorganisms and the interaction of salt levels and other processing parameters on the pathogenicity of food poisoning bacteria is being studied. The separate effects of salt, pH, temperature, water activity and culture medium component on food pathogens is under intensive systematic study.

Finally, the many possible interactions between environmental and media components will be studied and



Dr. James Smith is inoculating cultures for use in ongoing research on controlling growth and toxin production by food poisoning bacteria.